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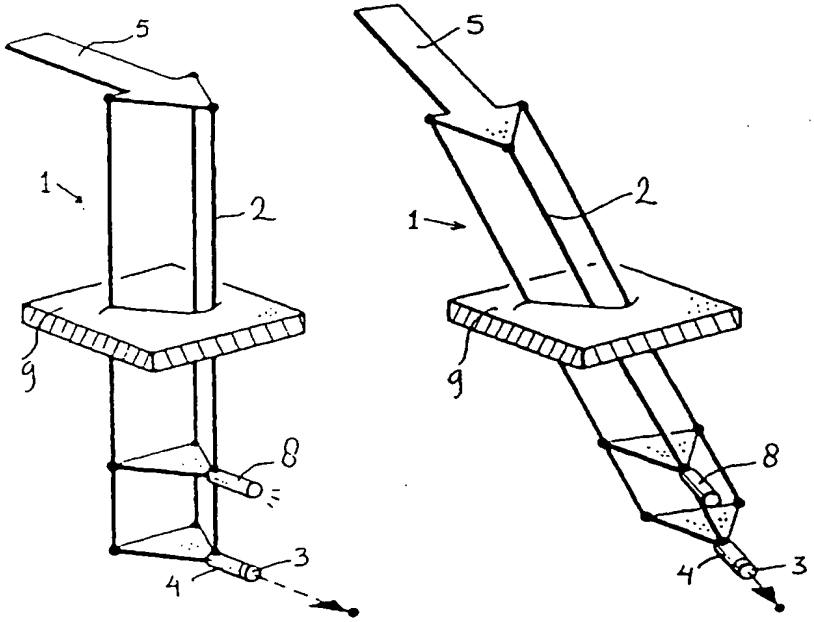
(54) Title: ENDOSCOPE




(57) Abstract: An endoscope (1) for use in minimally invasive surgery, comprises an inspection tube (2), provided with a light source (8). A lens (3) is positioned on an angularly adjustable lens holder (4) at the distal part of the inspection tube (2). A control organ (5), at the proximal end of the inspection tube (2) is coupled with the lens holder (4) for its adjustment in relation to the inspection tube. The light source (8) is positioned near the distal end at such a distance from the lens holder (4), that silhouettes perceivable by the lens (3) can be formed.

WO 01/10292 A1

Endoscope

The invention relates to an endoscope for use in minimally invasive surgery, comprising an inspection tube, which is provided with a light source and which at its distal end opens into a lens.

Such an endoscope is known, for example, from the article *Human sense of vision: a guide to future endoscopic imaging systems* by the authors M.O. Schurr, G. Buess, E. Kunert, E. Fleming, H. Henmeking and L. Gumb, published in Minimally Invasive Therapy and Allied Technologies; 1996; No. 5, p. 410-418.

The endoscope disclosed in this article is formed as a straight inspection tube with the lens looking ahead. Around the lens light conductors are provided for the illumination of the object to be inspected. The image obtained by such an endoscope is projected onto a monitor in order to provide the surgeon with visual information during the performance of the minimally invasive surgery. However, this type of the imaging entails problems with regard to the perception of distances and movements perpendicularly to the focal plane.

A first problem is that the surgeon accommodates to the focal plane of the monitor and not to the actual objects. Depth perception is therefore problematic. A further problem is that although the light source mounted around the lens provides a brighter image, it has an adverse effect on the surgeon's depth perception because of the absence of shadows.

An endoscope according to the preamble of claim 1 is known from US-A-3,572,325. In the endoscope known from US-A-3,572,325 the lens is positioned in the plane of the lens holder connected to the inspection tube, which lens holder is adjustable at an angle in relation to a substantial part of the inspection tube. This feature makes it possible for the lens together with the light source to be

repositioned without moving the inspection tube of the endoscope, so as to allow the image on the monitor connected to the endoscope to change in a natural manner. The adjustability of the lens holder with respect to the inspection tube thus provides an additional degree of freedom. The measures of freedom provided by said known endoscope are:

1. rotation of the inspection tube;
2. movement of the inspection tube coaxially with the endoscope;
3 and 4. Movement of the lens holder in the plane of viewing
5. the adjustability of the lens holder in respect of the inspection tube.

A sixth measure of freedom may be formed by the possibility to rotate the lens holder around its axis. This movement may optionally also be effectuated by video-processing of the image that can be obtained with the known endoscope.

The endoscope according to the invention is characterized in that the light source is positioned near the distal end at some distance from the lens holder, such that there is sufficient distance from the light source to the lens to form silhouettes which the lens is able to perceive. Using a light source in such a manner assists the endoscope's depth perception due to the shadow effect created as a result of the positioning of the light source.

It is further desirable that the light source in relation to the inspection tube be adjustable at an angle. In this way the shadow effect can always be obtained for the respective direction of viewing.

It is further advantageous for the light source to be adjustable simultaneously with the lens holder, to avoid the necessity of separate adjustment devices for operating the light source and the lens holder.

Desirably the lens holder is continuously adjustable in relation to the inspection tube between a

first position in the extended direction of the inspection tube, and a second position in which the lens holder forms an angle of approximately 110° in relation to the inspection tube. This measure allows the lens holder to be pointed forward when inserting the endoscope into the patient's body, which avoids undesirable damage to the patient's organs or other anatomical structures, while this considerable adjustability provides the additional possibility of viewing an object to be examined from all the angles that may be necessary in practice.

The measures of freedom provided by the endoscope according to the invention allow the unimpeded three-dimensional control of the image obtained therewith, irrespective of the position of the place of incision. With the endoscope according to the invention it is further possible to observe the examined anatomical structure from the side as well as from above and from below. The depth perception is greatly improved with the endoscope according to the invention, with the result that the surgeon's eye/hand coordination attains a higher level, and less previous training is required for the successful performance of minimally invasive surgery.

A convenient embodiment of the endoscope according to the invention is characterized in that at the proximal end, the inspection tube is provided with a handle, which is coupled with the lens holder for its adjustment in relation to the inspection tube. This allows the endoscope to be operated very simply by appropriately controlling the handle.

Desirably, the handle is coupled with the lens holder by means of the inspection tube and by means of a separate adjustment coupling. This affords a simple and reliable embodiment, which allows the endoscope according to the invention to be realized at relatively low costs.

A very suitable embodiment of said endoscope is thus characterized in that the handle and the lens holder are coupled cardanically with the inspection tube, and in that the adjustment coupling comprises control wires ar-

ranged between and coupled with the lens holder, such that the lens holder follows every movement of the handle. In this way the movement of the handle may be coupled directly with the lens holder, providing a one-to-one coupling between lens holder and handle. Conveniently, the handle may be shaped like an arrow. In this way the surgeon is able to obtain information regarding the viewing direction of the endoscope, whatever the position of the endoscope.

The invention will now be elucidated with reference to the drawings, which

in Figures 1a to 1c show a very schematic representation of the endoscope according to the invention in three possible positions; and

in Figure 2, schematically shows a few mechanical design aspects of the endoscope according to the invention.

Identical reference numbers used in the figures refer to similar parts.

The endoscope in the figures is generally indicated by reference number 1. Said endoscope 1 comprises an inspection tube 2 through which image signals are conveyed. The distal end of the inspection tube 2 opens into a lens 3. The lens 3 is positioned on a lens holder 4 connected with the inspection tube 2, which lens holder 4 can be adjusted at an angle in relation to the inspection tube 2. The images received via the lens 3 are processed further in the usual manner. For example, the lens 3 may be part of a camera that converts the image data into electronic signals. These electronic signals are subsequently processed in the usual manner and displayed on a video display unit. The person skilled in the art is quite familiar with this and there is no need for any further explanation.

The lens holder 4 is continuously adjustable in relation to the inspection tube 2 between a first position in the extended direction of the inspection tube 2, and a second position in which the lens holder 4 forms an angle

of approximately 110° in relation to the inspection tube 2. This allows the endoscope to assume various positions, just a few of which are shown in the Figures 1a to 1c. In each of these positions the endoscope is inserted through a patient's abdominal wall 9. Figure 1a shows a completely vertical position which corresponds with the prior art 90° endoscope. Figure 1b shows the position of the endoscope 1, wherein the lens 3 has been brought closer to the object to be observed, and Figure 1c shows an adjusted position of the endoscope 1, wherein the object of investigation is observed from one side. The Figures 1a to 1c clearly show that for the control of the position of the lens 3, the inspection tube 2 is provided at the proximal end with a preferably arrow-shaped handle 5, which is coupled with the lens holder 4. Preferably the handle is coupled with the lens holder 4 by means of the inspection tube 2 as well as by means of a separate adjustment coupling, a possible embodiment of which is shown in Figure 2. Figure 2 shows that the handle 5 and the lens holder 4 are each cardanically coupled with the inspection tube 2 and that the adjustment coupling comprises control wires 6 and 7 that run between and are coupled with the handle 5 and the lens holder 4, such that the lens holder 4 follows every movement of the handle 5. Due to the position of the arrow-shaped handle, the surgeon is constantly aware of the position of the lens holder.

The Figures 1a to 1c also show that the endoscope 1 according to the invention is preferably provided with a light source 8 mounted on the inspection tube 2 near the distal end of the inspection tube 2 at some distance from the lens holder 4. The light source 8 is preferably adjustable at an angle in relation to the inspection tube 2, in concurrence with the adjustability of the lens holder 4. One thing and another is preferably realized such that the light source 8 can be adjusted simultaneously with the lens holder 4, so that operating the handle 5 causes both the lens holder 4 and the light source 8 to be adjusted at the same time.

## CLAIMS

1. An endoscope (1) for use in minimally invasive surgery, comprising an inspection tube (2), which is provided with a light source (8) and which at its distal end opens into a lens (3) which is positioned on a lens holder (4), which lens holder (4) is adjustable at an angle in relation to a substantial part of the inspection tube (2), to which end the inspection tube at its proximal end is provided with a control organ (5), which is coupled with the lens holder (4) for its adjustment in relation to the inspection tube (2), **characterized** in that the light source (8) is positioned near the distal end at some distance from the lens holder (4), such that there is sufficient distance from the light source (8) to the lens (3) to form silhouettes which the lens (3) is able to perceive.

2. An endoscope according to claim 1, **characterized** in that the light source (8) in relation to the inspection tube (2) is adjustable at an angle.

3. An endoscope according to claim 1 or 2, **characterized** in that the light source (8) is adjustable simultaneously with the lens holder (4).

4. An endoscope according to one of the claims 1-3, **characterized** in that the lens holder (4) is continuously adjustable in relation to the inspection tube (2) between a first position in the extended direction of the inspection tube (2) and a second position in which the lens holder (4) forms an angle of approximately 110° in relation to the inspection tube (2).

5. An endoscope according to one of the preceding claims, **characterized** in that the control means is a handle (5), which is coupled with the lens holder (4) by means of the inspection tube (2) and by means of a separate adjustment coupling.

6. An endoscope according to claim 5, **character-**

ized in that the handle (5) and the lens holder (4) are coupled cardanically with the inspection tube (2), and in that the adjustment coupling comprises control wires (6,7) arranged between and coupled with the handle 5 and the lens holder (4), such that the lens holder (4) follows every movement of the handle (5).

7. An endoscope according to claim 5 or 6, characterized in that the handle (5) is shaped like an arrow.

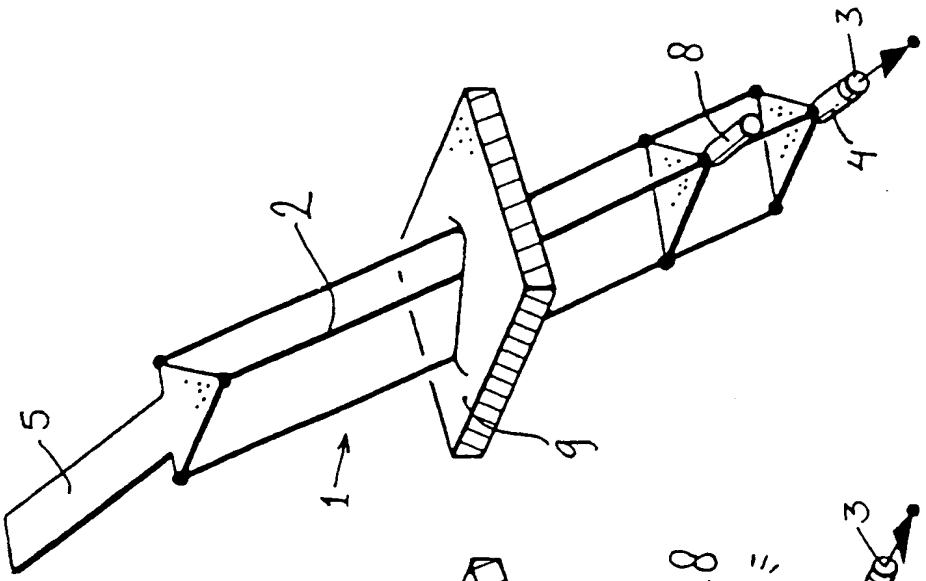



FIG. 1C

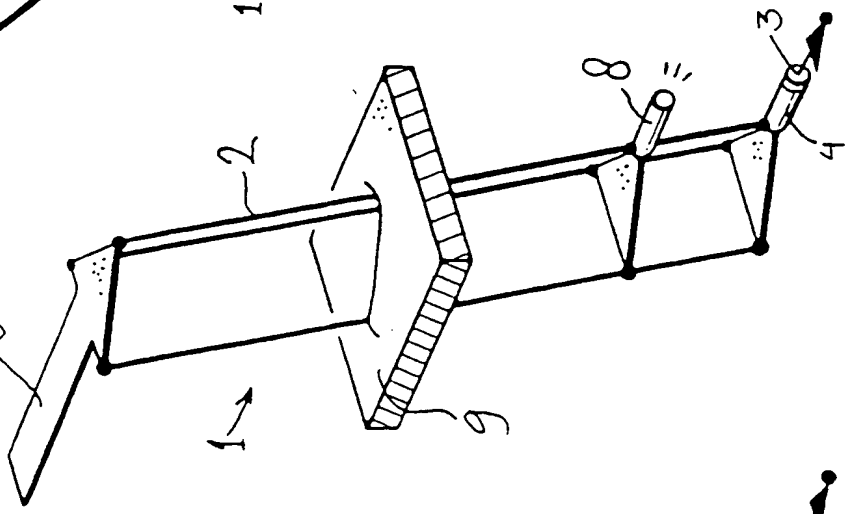



FIG. 1B

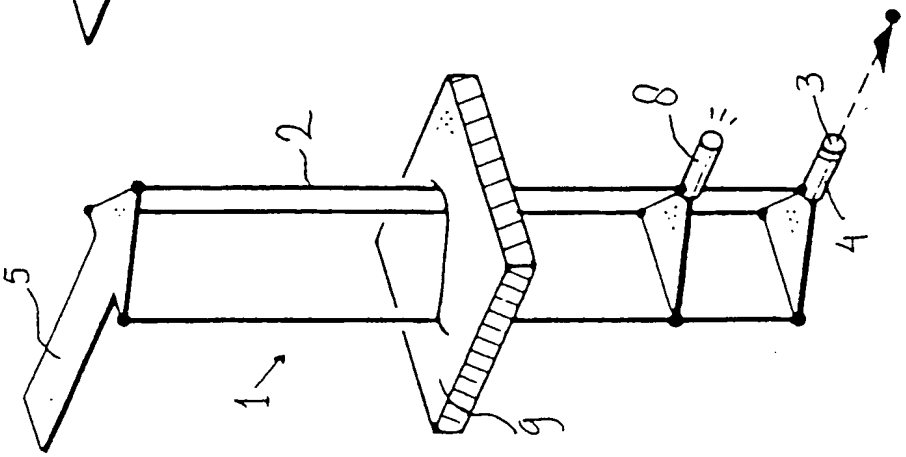



FIG. 1A

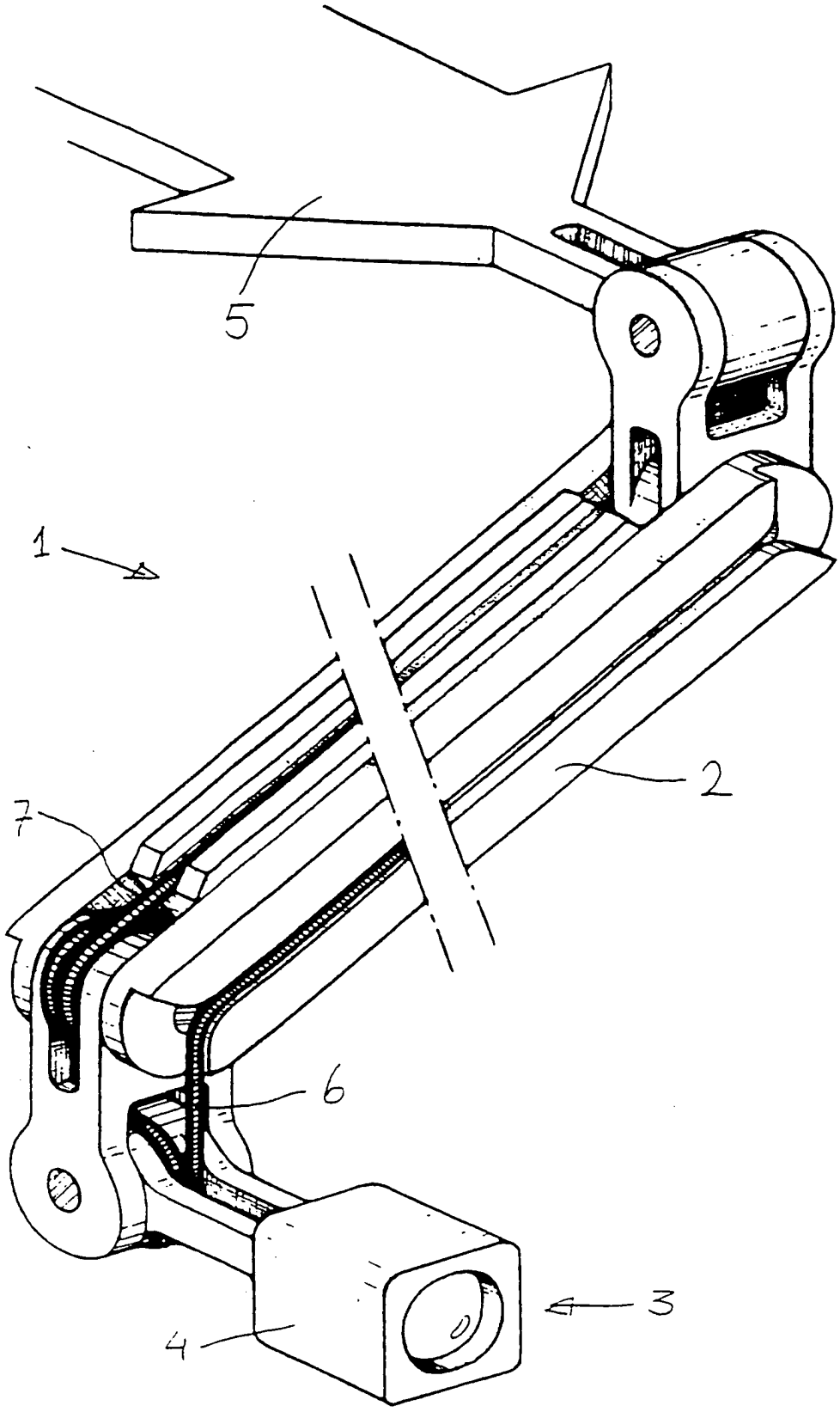



FIG. 2

# INTERNATIONAL SEARCH REPORT

Inte onal Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A61B1/05

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 6 November 2000 | 13/11/2000 |

| Name and mailing address of the ISA | Authorized officer |
|---|---|
| European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,<br>Fax: (+31-70) 340-3016 | Rieb, K.D. |

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International Application No
PCT/NL 00/00533

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